

**REMARKS**

Claim 1 has been amended to recite that the multi-functional material has (b) titanium, a titanium alloy, a titanium alloy oxide, or titanium oxide as a layer below the surface layer (support, for example, at paragraph [0017]), and that the carbon-doped titanium oxide layer contains [0.3] 1 to 15 at% of carbon (support at paragraph [0023]).

Review and reconsideration on the merits are requested.

Claims 1, 3, 4, 7, 8, 11, 12, 16 and 17 were rejected under 35 U.S.C. § 102(a) as being anticipated by Irie et al (Carbon-Doped Anatase TiO<sub>2</sub> Powders as a Visible Light Sensitive Photocatalyst). Irie et al was cited as disclosing a C-doped titanium alloy meeting the terms of the rejected claims.

In response, claim 1 has been amended to recite that the carbon-doped titanium oxide layer contains [0.3] 1 to 15 at% of carbon, to thereby distinguish over the carbon-doped anatase TiO<sub>2</sub> power of Irie et al having 0.32 at% substitution. Withdrawal of the foregoing rejection is respectfully requested.

Claims 1, 3, 4, 7, 8, 11, 12, 16 and 17 were rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,238,738 to McCurdy or U.S. Patent No. 6,194,346 to Tada et al or JP 2005-047786 (JP '786).

The rejection should be withdrawn because (i) Ti-C bond cannot be made by the chemical vapor deposition process of McCurdy; (ii) Ti-C bonds cannot be made by the sol-gel method of Tada et al; and (iii) JP '786 published February 24, 2005 subsequent to the December 8, 2004 PCT filing date of the present application is not available as prior art against the present claims. Applicants explain in further detail as follows.

McCurdy discloses

“A chemical vapor deposition process for depositing a titanium oxide coating on a glass substrate at deposition rates of at least 130 Å/sec, comprising:

- (a) pre-mixing a uniform, precursor gas mixture containing titanium tetrachloride and an ester, said ester having an alkyl group with a .beta. hydrogen;
- (b) delivering said precursor gas mixture at a temperature below the thermal decomposition temperature of said ester to a location near a glass substrate to be coated, said substrate being at a temperature above the thermal decomposition temperature of said ester; and
- (c) introducing said precursor gas mixture into a vapor space above said glass substrate wherein said ester thermally decomposes and thereby initiates a reaction with said titanium tetrachloride to produce a titanium oxide coating on said glass substrate.”

However, Ti-C bonds cannot be made by the chemical vapor deposition process of McCurdy.

Tada et al discloses

“Taking, for example, titanium oxide to form a photocatalyst layer on a base material by using sol-gel method, the inventors discovered that when the base material was coated with a sol-gel material, titanium alkoxide solution with fluorine compound, i.e., trifluoroacetic acid TFA), and then baked, the fluorine remained within the baked film, thereby increasing the photocatalytic activity. Also, increased electric conductivity due to fluorine doping may contribute to the improved photocatalytic activity” (column 7, lines 30-39).

However, Ti-C bonds cannot be made by the sol-gel method of Tada et al.

As noted above, JP ‘786 is not available as prior art against the present claims.

Withdrawal of the foregoing rejection is respectfully requested.

Claims 1, 3, 4, 7, 8, 11, 12, 16 and 17 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 7,175,911 to Zhou et al or U.S. Patent No. 6,863,987 to Kaneko et al.

The rejection should be withdrawn because (i) the heat-treatment temperature of 500°C to 620°C disclosed by Zhou et al is too low to form Ti-C bonds; and (ii) Ti-C bonds cannot be made by the process of Kaneko et al. Applicants explain in further detail below as follows.

Zhou et al (7,175,911) discloses

“A method for producing titanium dioxide fine particles according to claim 1, comprising: heat-treating titanium dioxide fine particles at a temperature of from 500°C or more to 620°C or less in an atmosphere of a nitrogen, carbon and hydrogen containing gas” (claim 2)

“A method for producing titanium dioxide fine particles according to claim 1, comprising: heat-treating titanium dioxide fine particles at a temperature of from 500°C or more to 620°C or less in an atmosphere of an NH<sub>3</sub> gas and carbon containing gas” (claim 3).

However, as explained in paragraph [0022] bridging pages 12-13 of the present specification:

“The carbon-doped titanium oxide layer having the carbon-doped in a state of Ti-C bonds is produced only by specific heat treatment. The heat treatment needs to be performed such that the surface temperature of the substrate is 900 to 1,500°C, preferably 1,000 to 1,200°C, and that a carbon-doped titanium oxide layer having carbon-doped in the state of Ti-C bonds is formed as the surface layer of the substrate. In the case of heat treatment resulting in the surface temperature of the substrate of lower than 900°C, the durability of the substrate having the resulting carbon-doped titanium oxide layer is insufficient, and its photocatalytic activity under visible light is also insufficient. In the case of heat treatment rendering the surface temperature of the substrate higher than 1,500°C, on the other hand, a super-thin film peels off the substrate

surface portion during cooling after heat treatment, and the effect of durability (high hardness, scratch resistance, wear resistance, chemical resistance, heat resistance) aimed at by the present invention is not obtained. Even with heat treatment leading to the surface temperature of the substrate within the range of 900 to 1,500°C, a prolonged heat treatment time causes peeling of a super-thin film from the substrate surface portion during cooling after heat treatment, and the effect of durability (high hardness, scratch resistance, wear resistance, chemical resistance, heat resistance) aimed at by the present invention is not obtained. Thus, the heat treatment time needs to be a time which does not cause peeling to the substrate surface portion during cooling after heat treatment. That is, the heat treatment time needs to be a time which is enough to convert the surface layer into a carbon-doped titanium oxide layer having carbon doped in the state of Ti-C bonds, but which does not cause peeling of the super-thin film from the substrate surface portion during cooling after heating. This heat treatment time is in correlation with the heating temperature, but is preferably about 400 seconds or less.”

Kaneko et al discloses

“A process of production of titanium resistant to discoloration in an atmospheric environment characterized by cold rolling the titanium, then annealing it in vacuum or an inert gas, then suitably thereafter mechanically or chemically removing at least 1  $\mu\text{m}$  of the titanium surface” (claim 5).

However, Ti-C bonds cannot be made by the process of Kaneko et al.

Withdrawal of the foregoing rejection is respectfully requested.

Claims 5, 6, 13 and 14 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Zhou et al or Tada et al or JP ‘786 or Irie et al in view of JP 2002-028998.

Applicants rely on the response above with respect to the rejection of each of the primary references.

Claims 9, 10 - 18-20 (the rejected claims are unclear) were rejected under 35 U.S.C. § 103(a) as being unpatentable over Zhou et al or Tada et al or JP '786 or Irie et al.

It seems that the Examiner meant to reject claims 9, 10 and 18-20 which relate to a titanium alloy, although claims 18-20 depend either primarily or secondarily from claim 12 which is not rejected.

Applicants rely on the response above with respect to the rejections of claim 1 over any of Zhou et al, Tada et al or JP '786 or Irie et al.

As shown above, the multi-functional material of the present invention differs from the materials of the cited references in terms of composition and/or structure.

Withdrawal of all rejections and allowance of claims 1 and 3-20 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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